RESOURCE NOTES

Genetic Effective Population Size in the Pryor Mountain Wild Horse Herd: Implications for conservation genetics and viability goals in wild horses

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Background

Genetics are typically presumed to be the least important component of minimum viable population predictions (and the population viability analysis process), and catastrophe is the most important. Catastrophe can be guarded against with large populations of longer predicted persistence times, but also with better management of any given population. Consider the concepts of food-limited ecological carrying capacity (hereafter ECC) and economic carrying capacity. The tarpan and Przewalski's wild horses of Europe and Asia might have been limited by predation by a combination of wolves, brown bears and one or more large cats, but predation (mostly by

mountain lions) is significant in only a very small number of wild horse herds in the US west. Most herds grow at phenomenal rates, for ungulates, of 16-22% per year. We observe that most wild horse herds are managed close to economic carrying capacity (which is typically 50-65% of ECC in numbers) and, at this lowered population level, animals are in better body condition, survival is higher (there is less starvation or dehydration), recruitment is higher, there is less conflict with other vertebrates and soil and vegetation resources, population fluctuations are less, and there is less risk of a resource-limited catastrophe.

Furthermore, while genetics is not a consideration in many free-ranging vertebrates, genetic conservation will become a serious consideration over future decades in wild horse management since so many of the herds are now isolated and small. In the Intermountain West region, 61% of all wild horse populations numbered less than 100 and 41% numbered less than 50 animals. Herds managed at these low numbers for decades might become inbred.

Discussion

Evidence from the Pryor Mountain wild horse herd supports the hypothesis that long-term management of wild horse numbers below the unmanaged maximum, has resulted in improved wild horse conditions, apparently improved range conditions, and a lower

probability of a large starvation losses. In the 1990's, foal rates were higher, 0.608, for the youngest breeding mares (3-5 year-olds), the most sensitive group to better conditions, than in the 1970-86 period, 0.392 (P=0.048). Population growth rates did not differ statistically between the periods (P=0.528), but numerical growth rates were higher (lambda =1.176) in the 1990's than in the 1970-86 period (lambda =1.119) and the coefficient of variation on growth rates was less (3.21 vs. 17.09) in the 1990's. Genetic effective population size (commonly referred to as N_e) is defined as the number of breeding individuals (both male and female) that contribute to the next generation. N_e is a useful number since it can be used to calculate the loss of genetic variation through genetic drift and/or inbreeding from one generation to the next with the formula $1/4N_e$. But N_e is a difficult number to calculate for wild horses, since the calculation is complicated by overlapping generations, a harem structure greatly limiting male participation in breeding (an uneven ratio of breeding sexes reduces N_e), high variance in reproductive success of both sexes, population fluctuations due to removals, and by a typical failure to breed until the age of 3 years for mares and 7 years for stallions. No single, universally acceptable formula exists to deal with these complexities.

We studied the population and mating dynamics of the Pyror

Mountain wild horse herd, 1992-98, in collaboration with a local volunteer (Rev. Floyd Schwieger) and Linda Coates-Markle of the Bureau of Land Management, Billings Resources Area. We found the 7 estimators for Ne averaged 27% of the census population size (N) until 1994. Birth sex ratio and management scenarios that resulted in more males on the range and smaller average harem size since 1994 (which increased male participation in breeding) increased Ne to 36% of census N.

The complexities of the loss of genetic resources were also investigated through a contract from USGS to John Gross, Colorado State University, who used a individually-based, stochastic simulation model. Management actions that were simulated included population sizes that varied from 130 to 1000, removals that were random or focused on young (0-8 years) or older (12-25 years) animals, and contraceptive applications that focused on young, or older horses. Simulations showed that populations managed with a target size of fewer than 500 horses were at some risk of losing more than 90% of selective neutral genetic variation over a long period of 200 years. Populations of more than 500 horses were at low risk. Removals or contraceptions that focused on young animals that delayed the average age of reproduction (and increased generation length) better maintained genetic diversity.

We are currently investigating the complexities of the simple calculations of Ne through detailed stallion parentage studies using DNA (to test how many foals are sired by harem stallions) and to test if high genetic heterozygosity is maintained through selection (i.e. is positively correlated to high reproductive success). This work is in collaboration with Gus Cothran of the Equine Studies Lab, University of Kentucky through a contract to USGS.

Conclusion

No standard goal for Ne or for loss of genetic resources currently exists for wild horse herds. If a goal of Ne=50 was applied, the goal for maintenance of domestic livestock production and thus probably an absolute minimum for a population in the wild, census N would need to be in excess of 139-185 wild horses, the excess to account for 3-5 removals per wild horse generation. Management could greatly alter this relationship by: (a) altering breeding sex ratios to increase Ne through removals, (b) increasing generation length through removal scenarios (which reduces the rate of loss of genetic resources, or (c) introducing breeding animals periodically from other genetically similar herds to maintain genetic resources. Only one to two breeding animals per generation (= about every 10 years in wild horses) would maintain the genetic resources in small populations of about 100 animals, thus obviating the need for larger populations in all cases. We stress that there is little imminent risk of inbreeding since most wild horse herds sampled have large amounts of genetic heterozygosity, genetic resources are lost slowly over periods of many generations, and wild horses are long-lived with long generation interval.

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